A new Late Pleistocene non-anthropogenic vertebrate assemblage from the northern Iberian Peninsula: Artazu VII (Arrasate, Basque Country)

Un nouvel assemblage de vertébrés non anthropiques de la fin du Pléistocène dans le Nord de la péninsule Ibérique : le site d'Artazu VII (Arrasate, Pays basque)

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A B S T R A C T

Late Pleistocene palaeontological sites without human intervention are limited in the Cantabrian region, and even more so those with a good state of preservation and rich biodiversity. A new vertebrate fossiliferous locality discovered at Kobate Quarry (Arrasate, northern Iberian Peninsula) is presented in this article. This site, in which remains of 40 different vertebrate taxa were accumulated, acted as a natural trap. The preliminary vertebrate faunal list includes five amphibian taxa, four reptiles, seven species of birds and 24 mammalian taxa. While small mammals are represented by 13 small mammal taxa (seven in the Order Rodentia, five in the Order Eulipotyphla, and one in the Order Chiroptera), the large mammal fauna comprises eleven species, including ungulates and carnivores. The palaeoecology inferred from this faunal assemblage suggests the existence of large forested areas with some grassland and a watercourse nearby, within a notably warm and humid climate. These palaeoenvironmental conditions, combined with AMS and AAR results carried out in macrofaunal bone samples, suggest that the deposit from Artazu VII would be located in the first half of the Late Pleistocene, in the Marine Isotope Stage (MIS) 5c.

R É S U M É

Les gisements paléontologiques de la fin du Pléistocène sont limités dans la région Cantabrique, et encore plus limités sont les sites ayant fourni des restes osseux en bon état de conservation et montrant une grande biodiversité. Nous présentons ici un nouveau site trouvé dans la carrière de Kobate (Arrasate, Nord de la péninsule Ibérique). Ce site a certainement agi comme un piège naturel et contient une accumulation de restes appartenant à 40 espèces différentes de vertébrés. La liste préliminaire de la faune de vertébrés comprend cinq taxons d'amphibiens, quatre de reptiles, sept espèces d'oiseaux et 24 taxons de mammifères. Alors que les mammifères sont représentés par 13 taxons de micromammifères (sept appartiennent à l'ordre Rodentia, cinq à l'ordre Eulipothypla, et un à l'ordre Chiroptera), les grands mammifères sont représentés par onze espèces, y compris des ongulés et des carnivores. Cette association faunique suggère un paléoenvironnement caractérisé par de vastes étendues boisées avec quelques prairies et un cours d'eau à proximité, dans un climat particulièrement chaud et humide. Ces conditions paléoenvironnementales, combinées à des datations AMS et AAR à partir d'échantillons d'os de la macrofaune, permettent de localiser le gisement d'Artazu VII dans la première moitié du Pléistocène supérieur, et plus précisement dans le stade isotopique marin (MEI) 5c.

1. Introduction

In 2012, a cave filled by silt and clay sediment, limestone blocks and accumulations of fauna was accidentally discovered following blasting in the Kobate Quarry (Arrasate, northern Iberian Peninsula). In 2013, after an emergency excavation carried out by María-José Iriarte and Álvaro Arrizabalaga all the material, both *in situ* and *ex situ*, was collected. The fossil bones belong to a Late Pleistocene assemblage. Notably, unlike nearby sites, no archaeological remains were found in the cave. The new locality was named Artazu VII.

In the North of the Iberian Peninsula, Pleistocene sites that are exclusively palaeontological or contain a palaeontological level, without evidence of human activity, are not common. Sites that acted as natural traps, thus better reflecting the fauna in the surroundings at that time, are even less frequent. In addition, few palaeontological deposits have been excavated systematically or their vertebrate assemblages studied fully. Examples from the western end of the Cantabrian region are the Galician sites of A Valiña (Fernández Rodríguez, 1989), Cova Eirós (Grandal D'Anglade, 1993) and Liñares (López, 2003) (Fig. 1A). In the central sector, known deposits are La Parte and Jou Puerta (Álvarez-Lao, 2014) in Asturias, and Peña Cabarga-Pico del Castillo (Castaños et al., 2012) in Cantabria (Fig. 1A). In the eastern end, the deposits of Punta Lucero (Castaños, 1988), Labeko Koba (Altuna and Mariezkurrena, 2000), Lezika (Castaños et al., 2009), Lezetxiki (Altuna, 1972), Lezetxiki II (Castaños et al., 2011) and Kiputz IX (Castaños et al., 2014) are located in the Basque Country (Fig. 1A).

Marine Isotopic Stage (MIS) 5 is often described as the last interglacial, a time when western Europe was covered by large broadleaf forests and areas free of ice increased in size, between 130 and 75 ka (Helmens, 2014). In the Iberian Peninsula, few palaeontological deposits are attributed to this period, and most of them are located in the Mediterranean region. Known sites are Hat (Panera et al., 2005) and Cueva del Camino (Arsuaga et al., 2012) in the centre of the Iberian Peninsula (Fig. 1A); Bolomor (Blasco, 2008), Cova Negra (Martínez Valle, 2009), Cova del Rinoceront (Daura et al., 2010) and Cova de les Teixoneres (Rosell et al., 2010) in the East of the Peninsula (Fig. 1A) and Troskaeta (Torres et al., 1993) in the North (Fig. 1A). From the sites mentioned previously, only La Parte and Peña Cabarga-Pico del Castillo are of the same chronology as Artazu VII.

Erosion caused by atmospheric agents in the carbonate rocks has created various karst systems along the upper Deba Valley, with numerous exokarst and endokarst landforms and Quaternary fills. During the last decades, the excavation and multidisciplinary study of some of these openings enriched significantly the evidence of human presence and the information about the palaeoecological conditions during the Pleistocene. In the area of Artazu VII (Arrasate, Basque Country, Northern Iberian Peninsula), the subject of the present study, the fossiliferous locality of Artazu II (placed 550 m to the north-east from Artazu VII in a straight line) has been interpreted, based on its lithic assemblage, as the oldest Palaeolithic deposit in Gipuzkoa, dated to 120–220 ka (Arrizabalaga and Iriarte, 2011). The nearby Lezetxiki complex, formed by the caves Lezetxiki and Lezetxiki II and located 180 m to the northwest in the straight line (Altuna, 1972; Barandiarán, 1965), yielded the oldest human remains in the Basque Country and also the most recent *Macaca sylvanus* fossil in the northern Iberian Peninsula (Castaños et al., 2011), besides the record of some species (*Sicista betulina* and *Muscardinus avellanarius*) not found elsewhere in the Quaternary of the Iberian Peninsula (Garcia-Ibaibarriaga et al., 2015; Rofes et al., 2012).

The aim of the present paper is to present a new palaeontological site in the northern fringe of the Iberian Peninsula. Due to the large number of remains, it has still not been possible to carry out the biometric and morphological study of the entire Artazu VII assemblage or to perform a palynological analysis. Thus, this paper represents an interim study with an inventory of the different vertebrate taxa found at this site and a general palaeoenvironmental reconstruction of its surroundings.

2. Geographical and geological setting

Artazu VII was located in Kobate Quarry (Arrasate, Basque Country, northern Iberian Peninsula), on the southwestern side of Mount Artazu at 351 m above sea level (UTM coordinates; X: 538241, Y: 4769155; datum WGS84 and Zone 30 T; Fig. 1A, B). Geologically, mount Artazu

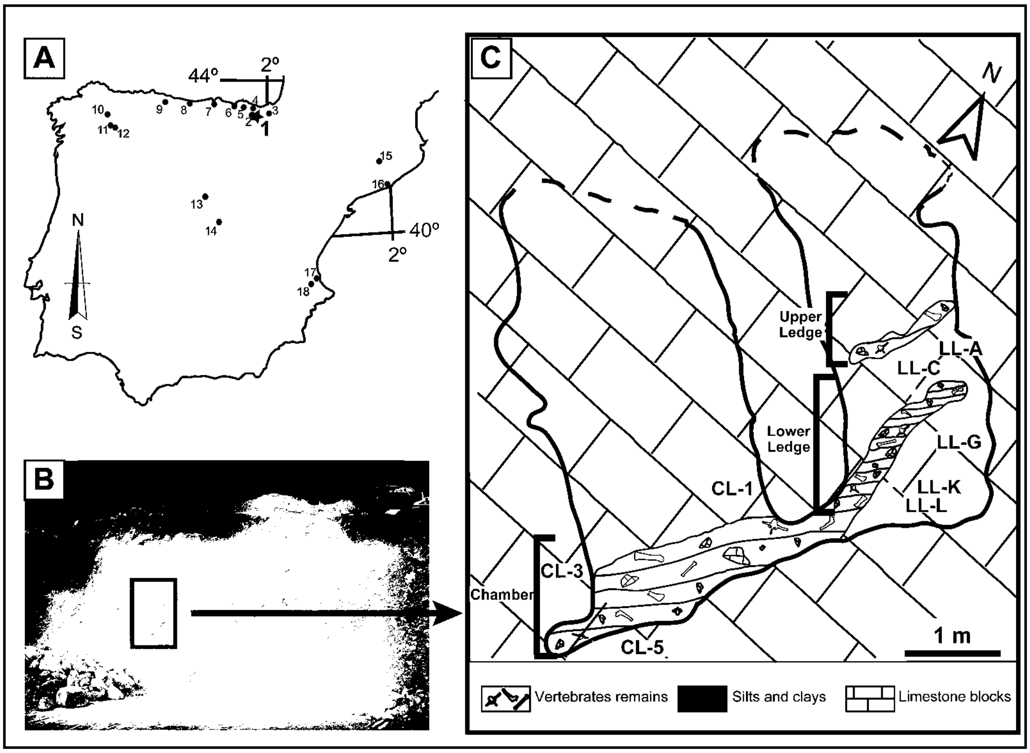

Fig. 1. **A.** Geographic situation of Artazu VII (Arrasate, Gipuzkoa). 1) Lezetxiki, Lezetxiki II and with star Artazu VII cave, 2) Labeko Koba, 3) Troskaeta, 4) Kiputz IX, 5) Lezika, 6) Punta Lucero, 7) Peña Cabarga-Pico del Castillo, 8) Jou Puerta, 9) La Parte, 10) A Valiña, 11) Cova Eirós, 12) Liñares, 13) Cueva del Camino, 14) Hat, 15) Cova de les Teixoneres, 16) Cova del Rinoceront, 17) Bolomor and 18) Cova Negra. **B.** Inside the box Artazu VII chasm. **C.** Stratigraphic sequence. Three deposit zones can be observed: Upper Ledge (UL), Lower Ledge (LL) and Chamber (C). The levels studied in this work are: Lower Ledge A (LL-A), Lower Ledge C (LL-C), Lower Ledge G (LL-G), Lower Ledge K (LL-K), Lower Ledge L (LL-L), Chamber Layer 1 (CL-1), Chamber Layer 3 (CL-3) and Chamber Layer 5 (CL-5).

Fig. 1. **A.** Situation géographique de l'aven d'Artazu VII (Arrasate, Gipuzkoa). 1) Lezetxiki, Lezetxiki II et avec une étoile pour le gisement Artazu VII, 2) Labeko Koba, 3) Troskaeta, 4) Kiputz IX, 5) Lezika, 6) Punta Lucero, 7) Peña Cabarga-Pico del Castillo, 8) Jou Puerta, 9) La Parte, 10) A Valiña, 11) Cova Eirós, 12) Liñares, 13) Cueva del Camino, 14) Hat, 15) Cova de les Teixoneres, 16) Cova del Rinoceront, 17) Bolomor et 18) Cova Negra. **B.** Intérieur de la boîte Artazu VII abîmé. **C.** Séquence stratigraphique. Trois zones de dépôt peuvent être observées : rebord supérieur (UL), rebord inférieur (LL) et chambre (C). Les niveaux étudiés dans ce travail sont : rebord inférieur A (LL-A), rebord inférieur C (LL-C), rebord inférieur G (LL-G), rebord inférieur K (LL-K), rebord inférieur L (LL-L), chambre couche 1 (CL-1), chambre couche 3 (CL-3) et chambre couche 5 (CL-5).

is located in Aptian/Albian (Cretaceous) limestones characterized by abundant rudists and corals, which form anticlinal and synclinal structures on a NW-SE line (EVE, 1995) and is bounded by three mountain ranges: one is formed by the peaks of Udalaitz (1090 m), Tellamendi (830 m) and Murugain (775 m), the second by Atzabal (1168 m) and Karraskagain (400 m) and the third by Anboto (1268 m) and Kurtzebarri (1155 m). Moreover, Artazu VII site is located on the edge of a steep slope on the hill.

During the rescue excavation of the deposit in 2013, three areas have been differentiated in accordance with the shape of the fissures: Upper Ledge (a fissure in the upper part of the site), Lower Ledge (a fissure in the intermediate part) and Chamber (the last space in the cave) (Fig. 1C).

3. Materials and methods

3.1. Collection techniques

The material recovered from Artazu VII consists of microfaunal (amphibians, reptiles, birds and small mammals) and macrofaunal (ungulates and carnivores) remains collected from the sedimentary fill of the fissure. The site was located in a zone that was to be destroyed because it was inside a working quarry, so all the sediment remaining inside was removed. In total, seventeen 7–15 cm thick arbitrary spits were excavated (Fig. 1C). These spits were designated in descending order from top to bottom, each one being allocated a depth, a letter or number. Thus, in the Upper Ledge they were ordered by depth (0–15), in the Lower Ledge alphabetically (from A to L) and in the Chamber numerically (from 1 to 5) (Fig. 1C). Most of the macrofaunal remains were disturbed, with species and individuals totally mixed, both horizontally and vertically; even with different anatomical elements corresponding to a single individual were distributed in more than one spit. Therefore, no squares and sectors were established. Also, we also studied all the material of macrofauna without stratigraphic context, so as to compose a list of all taxa present in Artazu VII.

While the macrofauna remains were being collected, all the sediment inside the fissure was removed to extract the microfauna. Two samples were taken from the Upper Ledge (total sediment volume: 2.5 L), twelve in the Lower Ledge (total sediment volume: 156 L) and five in the Chamber (total sediment volume: 82 L), amounting to an overall sediment volume of 240.5 L. The present study analyses part of Samples A, C, G, K and L from the Lower Ledge and Layers 1, 3 and 5 from the Chamber, representing a total sediment volume of 55.25 L. These samples were chosen because they were on the two sides of the cave, near its top and bottom, and therefore represent the whole stratigraphic column. The sediment samples were washed and sieved using an upper screen with a 2 mm mesh and a lower 0.5 mm mesh. The fossil remains were selected and grouped according to anatomical criteria. The dental elements were studied first because they are more diagnostic for taxonomical identification. The specimens were photographed and measured with a Nikon SMZ 1500 stereomicroscope at 10 × magnification in the Stratigraphy and Palaeontology Department at the University of the Basque Country (UPV-EHU). All recovered material will be storage in Gordailua [Cultural Heritage Center of Gipuzkoa, Irun (Spain)].

3.2. *Dating techniques*

A bone sample was selected for an Accelerator Mass Spectrometry (AMS) radiocarbon determination to establish the exact age of the deposit. The bone chosen was a *Rupricapra pyrenaica* metapodial, because of its consistency and good state of preservation. It came from the Upper Ledge (Fig. 1C), which, *a priori*, is the most recent part of the deposit. The sample was sent to Beta Analytic (Florida) and it yielded the minimum weight of 1 to 2 g collagen. The sample proved to be outside the maximum age limit for Beta Analytic (43.5 ka), showing it was at least not referable to the later part of the Late Pleistocene.

As it was also impossible to date the deposit with the U/Th technique owing to the absence of speleothems within the deposit, the method of amino acid racemization (AAR) was applied in the Artazu VII site, the only dating method that can be used in these chronologies, as in Las Callejuelas (Domingo et al., 2015). The dating of palaeontological and archaeological sites using AAR analysis has become a reliable method, despite certain difficulties. The amount of amino acids in organisms with carbonate shells depends on diverse factors related to the depositional environment, taphonomical processes (mechanical fragmentation or bioerosion) and chemical dissolution (Carroll et al., 2003; Davies et al., 1989; Kidwell, 1998; Kidwell et al., 2005; Meldahl et al., 1997). Moreover, different results for the same chronology can be explained by the absorption of solar radiation according to the orientation of the entrance of the site (Ortiz et al., 2015a). In addition, several studies have reported variations in the ratio of measured amino acids depending on the part of the organisms with carbonate shells from which the sample is recovered (Haugen and Sejrup, 1992; Ortiz et al., 2015b; Wehmiller, 1980). Furthermore, racemization analysis varies depending on the genus and species examined (Murray-Wallace, 1995), so it should be preferable to analyze samples of the same species, or at least, of the same genus.

In Artazu VII, to reduce taxonomically controlled variability in measured values, AAR was applied to 16 gastropods belonging to two genera (eight to *Clausilia* sp. and eight to *Xerosecta* sp.) and two *Panthera pardus* dental elements. Analyzed gastropods were extracted from Upper Ledge (spits A, C, G, K and L) and from Chamber (layers 1, 3 and 5) (Fig. 1), collecting the same two genera for each spit. In this way, it was possible to contrast two dating for each level. The first sample of panther was an upper left canine from Lower Ledge Level L (LEB-14069) and the second was a lower left first molar from Layer K (LEB-14070) in the Lower Ledge. All samples were sent to the Biomolecular Stratigraphy Laboratory (LEB) in the Higher School of Mining Engineers in Madrid (E.T.S.I de Minas). They were prepared according to the LEB protocol (Torres et al., 2014) and analysed in an Agilent HPLC-1100 high performance liquid chromatograph with a fluorescence detector, taking between 17 and 36.3 mg of each sample. The elements being analysed were subjected to hydrolysis and derivatization processes, using hydrochloric acid hydrolysis and an automatic injector with three mobile phases for the derivatization. The AAR results were obtained based on the D/L relationships for each amino acid identified and the total contents (pmol/mg) of each enantiomer (Torres et al., 2014).

3.3. *Habitat types and climate categories*

The most of the taxa identified at the site still exist today, which means that the correlation between species and habitats is quite reliable. Four habitats have been defined in accordance with the ecological preferences of each species, after the studies of Berto (2013), Cuenca-Bescós et al. (2009), Pemán (1985), Pokines (1998) and Sesé (2005). These habitats are: woodland (scrubland and edges of forests with moderate cover), grassland (open environments with certain humidity, also with dense pastures and high plant cover), aquatic environments (any kind of surface water environment, either a watercourse or ponded water: streams, lakes, ponds, bogs and marshes) and crags (open areas with a rocky substrate, generally above woodland, but not necessarily a montane environment). However, this classification occasionally lacks clear boundaries as the transitions between them can be gradual.

4. Results and discussion

4.1. *Site formation*

The partial destruction of the site prevents the reconstruction of the morphology of the cave. However, the preliminary evidence suggests that Artazu VII was a karstic cavity that acted as a natural trap. All remains preserved in the site display no signs of biological action due to carnivore activity. Additionally, the absence of human activity evidences, such as cut marks by artefacts or intentional breakage features discarded the possibility of anthropogenic origin. Besides, many macrofaunal remains were even found in anatomical connection.

In contrast, normally, the microfauna is accumulated as part of the food of birds of prey. Accumulations of microfauna in caves tend to be the result of the action of predators, either from owl pellets or the scats of small carnivores (Andrews, 1990). This action causes physical (tooth

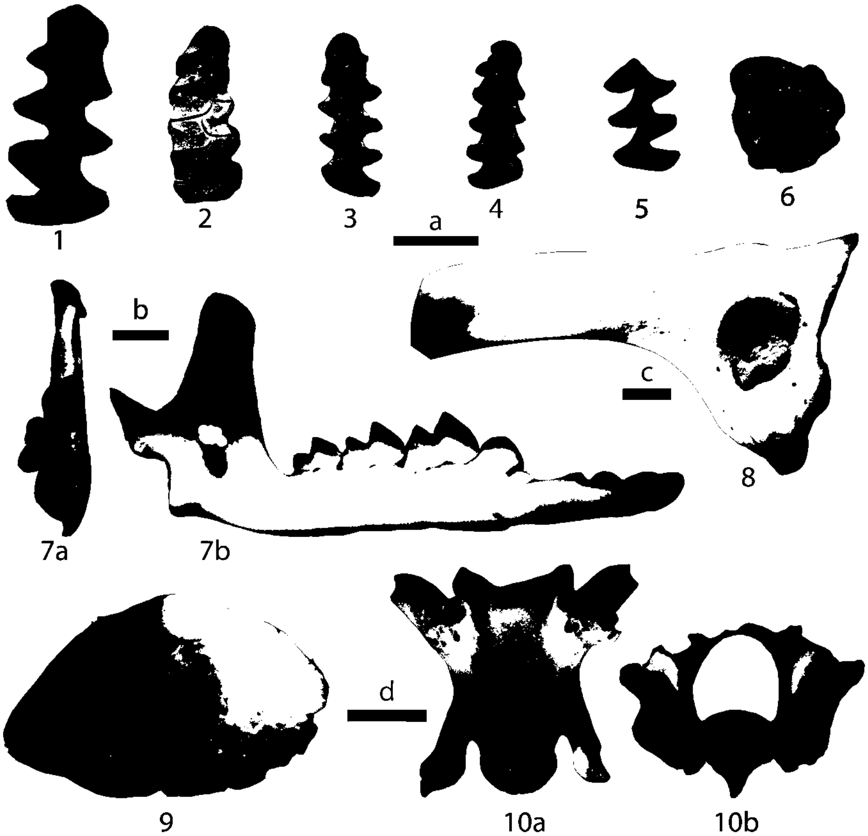

Fig. 2. **1:** *Arvicola sapidus*, occlusal view of right m_1. **2:** *Microtus (Microtus) agrestis*, occlusal view of right m_1. **3:** *Microtus (Microtus) arvalis*, occlusal view of left m_1. **4:** *Microtus (Terricola)* sp., occlusal view of right m_1. **5:** *Pliomys lenki*, occlusal view of left m_3. **6:** *Apodemus sylvaticus-flavicollis*, occlusal view of left M^2. **7:** *Sorex (Sorex) araneus-coronatus*, right mandible, **a**; back view, **b**; labial view. **8:** *Bufo bufo*, left ilium. **9:** *Aguis fragilis* osteroderm. **10:** *Vipera* sp., trunk vertebrae **a**; vental view **b**; posterior view. Scale bars = 1 mm, a for figs. 1–6, b for figs. 7a–7b, c for fig. 8 and d for figs. 9–10b.

Fig. 2. **1 :** *Arvicola sapidus*, m_1 droite, vue oclusale. **2 :** *Microtus (Microtus) agrestis*, m_1 droite, vue oclusale. **3 :** *Microtus (Microtus) arvalis*, m_1 gauche, vue oclusale. **4 :** *Microtus (Terricola)* sp., m_1 droite, vue oclusale. **5 :** *Pliomys lenki*, m_3 gauche, vue oclusale **6 :** *Apodemus sylvaticus-flavicollis*, M^2 gauche, vue oclusale. **7 :** *Sorex (Sorex) araneus-coronatus*, mandibule droite, **a** ; vue labiale **b** ; vue postérieure. **8 :** *Bufo bufo*, ilium gauche. **9 :** *Anguis fragilis*, ostéoderme. **10 :** *Vipera* sp., vertèbre dorsale, **a** ; vue ventrale, **b** ; vue postérieure. Barres d'échelle = 1 mm, a pour les fig. 1–6, b pour les figs. 7a–7b, c pour la fig. 8 et d pour les figs. 9–10b.

marks) and/or chemical traces (corrosion by gastric juices) on the bones to a greater or lesser extent (Andrews, 1990). In Artazu VII, the microfaunal bones hardly display any evidence of digestion, so nocturnal owls were probably the potential agents producing the accumulation of small vertebrates in the sequence. Nevertheless, we cannot rule out the possible accidental incorporation of the microvertebrates to the site.

In addition, some of the remains exhibit post-depositional fractures, so that after the accumulation has formed, the remains are thought to have been disseminated by some kind of flow (water, mud…) that deposited them in the final part of the cave.

4.2. Small vertebrate and large mammal assemblages

Artazu VII has yielded a large number of remains of great taxonomical diversity, as regards both the macrofauna and the microfauna, and consequently the detailed biometric and morphological study is still in progress. Because most of the macrofaunal remains were found whole or with post-depositional fractures, with many of them preserving anatomical connections, this excellent preservation allows the palaeobiological interpretation and general palaeoenvironmental reconstruction in the present study.

The microvertebrate assemblage consists of herpetofauna, avifauna and small mammals. Within the herpetofauna, amphibians are represented by five taxa (Salamandridae indet., *Alytes obstetricans*, *Bufo bufo*, *Hyla arborea* and *Rana temporaria-iberica*) and the reptiles by four (Lacertidae indet., *Anguis fragilis*, *Coronella girondica* and *Vipera seoanei*) (Fig. 2, Table 1). Among the amphibians, the most common specie is *R. temporaria-iberica*, while among the reptiles, the most numerous taxon is Lacertidae indet. *R. temporaria-iberica* and the Lacertidae indet. belong to families with species that nowadays live to the north of the Atlantic-Mediterranean watershed in the Basque Country, and inhabit areas with certain plant cover, mainly broadleaf and mixed forests, near almost permanent sources of water. The avifauna consists of seven species (*Perdix perdix*, *Coturnix coturnix*, *Lyrurus tetrix*, *Bubo Bubo*, *Pica pica*, *Pyrrhocorax pyrrhocorax* and *P. graculus*)

Table 1
Preliminary taxonomic inventory of vertrebrates of Artazu vii.
Tableau 1
Inventaire taxonomique préliminaire des vertébrés du gisement d'Artazu VII.

Caudata	**Galliforme**	**Rodentia**	**Chiroptera**
Salamandridae indet.	*Coturnix coturnix*	*Apodemus sylvaticus-flavicollis*	Chiroptera indet.
	Lyrurus tetrix	*Arvicola amphibius*	
	Perdix perdix	*Arvicola sapidus*	**Artiodactyla**
Anura		*Microtus (Microtus) agrestis*	*Bison priscus*
Alytes obstetricans		*Microtus (Microtus) arvalis*	*Cervus elaphus*
Bufo bufo	**Strigiforme**	*Microtus (Terricola)* sp.	*Rupicapra pyrenaica*
Hyla arborea	*Bubo bubo*	*Pliomys lenki*	
Rana temporaria-iberica			**Carnivora**
			Canis lupus
			Felis silvestris
		Eulipotyphla	*Lynx* sp.
Squamata		*Erinaceus europaeus*	*Martes* sp.
Anguis fragilis	**Passeriforme**	*Sorex (Sorex) araneus-coronatus*	*Mustela lutreola*
Coronella giroconda	*Pica pica*	*Sorex (Sorex) minutus*	*Panthera pardus*
Lacertidae indet.	*Pyrrhocorax graculus*	*Neomys* sp.	*Panthera spelaea*
Vipera seoanei	*Pyrrhocorax pyrrhocorax*	*Talpa* sp.	*Vulpes vulpes*

(Table 1). The most abundant taxa remains are the two species of the genus *Pyrrhocorax*.

Within the small mammals, 13 species have been identified, belonging to the Orders Rodentia (*Arvicola sapidus*, *A. amphibius*, *Microtus (Microtus) agrestis*, *M. (Microtus) arvalis*, *M. (Terricola)* sp., *Pliomys lenki* and *Apodemus sylvaticus-flavicollis*) Eulipotyphla (*Sorex [Sorex] araneus-coronatus*, *S. [Sorex] minutus*, *Neomys* sp., *Talpa* sp. and *Erinaceus europaeus*) and Chiroptera (indeterminate Chiroptera) (Fig. 2, Table 1). The most abundant Orders are Rodentia and Eulipothypla, with the species *A. sylvaticus-flavicollis*, *S. araneus-coronatus* and *S. minutus*. The first appearance of *P. lenki* in the Iberian Peninsula was in the Early Pleistocene and it persists until the Early Holocene (Cuenca-Bescós et al., 2009). Some authors associate this rodent with a woodland environment (Pokines, 1998; Rofes et al., 2014; Sesé, 2005). The group *A. sylvaticus-flavicollis* have also lived in Iberia since the Early Pleistocene (Maul, 1990), and are indicative of tree cover and characteristic of the temperate climate in northern Spain, as clearly shown by their Holocene presence at the sites of Santimamiñe (Rofes et al., 2014) and Peña Larga (Rofes et al., 2013) and the Late Pleistocene site of Antoliña Koba (Rofes et al., 2015). Finally, the group *S. araneus-coronatus* and the species *S. minutus* live in continental climates and are associated with very humid environments, preferably temperate, with dense plant cover (Cuenca-Bescós et al., 2009; Rofes, 2009). It should be noted that no species associated with cold climates (e.g. *Microtus [Alexandromys] oeconomus*) have been found (Cuenca-Bescós et al., 2009) in Artazu VII.

Ungulates and carnivores form the large mammal assemblage: three ungulate species (*Bison priscus*, *Rupicapra pyrenaica* and *Cervus elaphus*), and eight carnivore taxa (*Panthera spelaea*, *P. pardus*, *Lynx* sp., *Felis silvestris*, *Canis lupus*, *Vulpes vulpes*, *Mustela lutreola* and *Martes* sp.) (Fig. 3, Table 1). The best represented species is *Rupicapra pyrenaica*, followed by *P. pardus* and *C. elaphus*. The taxonomical association of the large mammals suggests a complex environment consisting of a landscape with different habitats. The presence of a main sample of *R. pyrenaica* indicates the existence of areas of rocky mountains next to the site. The existence of forest near the site is justified by the presence of species such as the *P. pardus*, *P. spelaea*, *Lynx* sp. and *F. silvestris*. Besides, the presence of members of a steppe bison (*B. priscus*) and *Panthera* genera are consistent with some grassland in the surroundings, next to the forest assemblage. This landscape is complemented by the existence of freshwater currents nearby, as attested by the presence in the sample of species such as *M. lutreola*.

4.3. Chronology

Given the material fell outside the range of radiocarbon dating, 18 AAR dates were obtained for other large mammal and gastropods remains. The results provided by the gastropods racemization are inconsistent for several reasons. On the one hand, in the same level, the gastropods AAR had a difference of about 30 ka. On the other hand, numerous datings are inverted and show non-consistent results, without any order. As was mentioned before, AAR in carbonate shells depends on many factors, and although it all necessary precautions were taken, the results are inconclusive. A similar observation has also been made in other works with AAR, like Penkman et al. (2008) and Ortiz et al.

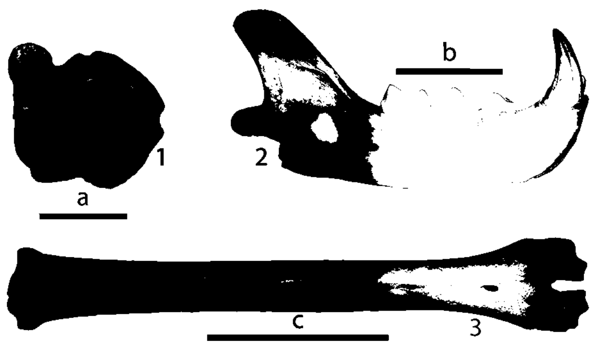

Fig. 3. **1:** *Bison priscus*, left centrotarsal. **2:** *Panthera pardus*, labial view of right mandible. **3:** *Rupicapra pyrenaica*, right metatarsal. Scale bars = 5 cm, a for 1, b for 2 and c for 3.
Fig. 3. **1 :** *Bison priscus*, centrotarsien gauche. **2 :** *Panthera pardus*, mandibule droite en vue labiale. **3 :** *Ruiycapra pyrenaica*, métatarsien droit. Barres d'échelle = 5 cm, a pour 1, b pour 2 et c pour 3.

Table 2
Amino acid racemizations age in two samples of *Panthera pardus* from LL-L (Lower Ledge L) and LL-K (Lower Ledge K) from Artazu VII (Arrasate, Gipuzkoa, Basque Country).
Tableau 2
Âge par racémisation des acides aminés de deux échantillons de *Panthera pardus* du rebord inférieur L (LL-L) et du rebord inférieur K (LL-K) de l'aven d'Artazu VII (Arrasate, Gipuzkoa, Pays basque).

Amino acid sample	LEB-14069	LEB-14070
Weight (mg)	19.8	17
Aspartic D	824.14	726.50
Aspartic L	7234.17	5796.72
D/L Asp	0.114	0.125
Glutamic D	550.91	503.33
Glutamic L	12020.33	9763.02
Glu D/L	0.046	0.052
Serine D	142.72	116.28
Serine L	4845.09	3686.20
Ser D/L	0.029	0.032
Age (ka)	**88.5**	**98.4**

(2013). Ortiz et al. (2015a) noticed that ostracods racemization speed varies depending on the marine influence (pH, salinity, . . .). They also noted that the concentration of amino acid present in *Patella Vulgate* shells, varies within the same archaeological level (Ortiz et al., 2015a). The AAR results obtained from the panther samples are more consistent with AMS results. The one from Lower Ledge Layer L (LEB-14069) gave an age of 88,500 years, while the other, from Lower Ledge Layer K (LEB-14070) was dated to 98,400 years (Table 2). This chronological inversion has been interpreted as being influenced by atmospheric temperature inside the palaeontological site. Although these results do not help to know the exact age, they are valid to give an approximate age. Roughly, the mean value between both AAR datings is 93,000 years, so Lower Ledge (Fig. 1C) can be dated to the early Late Pleistocene.

Deep ice cores from central Greenland provide a long climate record going back to 122 ka, differentiating alternating cold and warm periods. The AAR dates and general environmental data from Artazu VII have been correlated with the $\delta^{18}O$ curve obtained by the North Greenland Ice Core Project, 2004 (NGRIP). According to ARR datings, the deposit of Artazu VII corresponds to the previous interglacial MIS 5 (Helmens, 2014). Whereas MIS 5b represents a period of cooling with an open environment and sub-Arctic and sub-Alpine steppe species (Helmens, 2014), MIS 5c is interpreted as a warmer period, in which broadleaf forests spread in a temperate climate. The transition from MIS 5d to MIS 5c is marked by the disappearance of the deciduous woodland and the spread of coniferous forests, indicative of cold, dry climates (Helmens, 2014). Artazu VII shows a relatively temperate climate, so it would correspond with substages 5c and/or 5b. Therefore, it is tentatively correlated to MIS 5c because of the large development of woodland.

5. Summary and conclusions

Artazu VII is a new site discovered in 2012 in Kobate Quarry (Arraste, Basque Country). It is one of the best palaeontological deposits, without human interaction, from the Late Pleistocene, not only from northern Spain but in the whole Iberian Peninsula because it acted as a natural trap.

A total of 40 vertebrate taxa have been identified. A general palaeoenvironmental reconstruction in the Arrasate area (upper Deba Valley) has been done based on the ecological preferences of the most abundant taxa among the small vertebrates in the deposit: *S. araneus-coronatus*, *S. minutus*, and *A. sylvaticus-flavicollis* within the small mammals, *R. temporaria-iberica* and Lacertidae indet. in the herpetofauna, and the species that better represent the environment among the large mammals *R. pyrenaica*, *P. pardus*, *P. spelaea*, *Lynx* sp. and *F. silvestris*. Bearing in mind that the fissure was filled in the MIS 5c, a humid habitat with a predominance of grassland and broadleaf forests, with some practically permanent water sources, has been inferred. The absence of species characteristic of cold climates and the large number of indicators of a relatively warm climate (e.g. the genus *Apodemus*) show that the atmospheric temperature was similar to present conditions.

The large number of remains, their taxonomical diversity and good state of preservation allow a palaeoenvironmental reconstruction, showing a warm period in which deciduous forests expanded. The AAR dates of 98.4 ka and 88.5 ka, obtained for bone samples from Layers L and K in the Lower Ledge, support an attribution of Artazu VII to the first half of the Late Pleistocene, in the MIS 5c substage.

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References

Altuna, J., 1972. Fauna de mamíferos de los yacimientos prehistóricos de Guipúzcoa, con catálogo de los mamíferos cuaternarios del Cantábrico y del Pirineo Occidental. Munibe 24, 1–464.
Altuna, J., Mariezkurrena, K., 2000. Macromamíferos del yacimiento de Labeko Koba (Arrasate, País Vasco). Munibe 52, 107–181.
Álvarez-Lao, D.J., 2014. The Jou Puerta cave (Asturias, NW Spain): a MIS 3 large mammal assemblage with mixture of cold and temperate elements. Palaeogeogr. Palaeoclimatol. Palaeoecol. 393, 1–19.
Andrews, P., 1990. Owls, Caves and Fossils. The Natural History Museum Publications, London, pp. 1–231.
Arrizabalaga, A., Iriarte, M.J., 2011. Los grupos de cazadores-recolectores en la prehistoria de Gipuzkoa. Arkeologia Gipuzkoako Foru Aldundia., pp. 297.
Arsuaga, J.L., Baquedano, E., Pérez-González, A., Sala, N., Quam, R.M., Rodríguez, L., Garcíae, R., Garcíaa, N., Álvarez-Lao, D.J., Laplana, C., Huguet, R., Sevilla, P., Maldonado, E., Blain, H.-A., Ruiz-Zapata, M.B., Sala, P., Gil-García, M.J., Uzquiano, P., Pantoja, A., Márquez, B., 2012.

Understanding the ancient habitats of the last-interglacial (late MIS 5) Neanderthals of central Iberia: Paleoenvironmental and taphonomic evidence from the Cueva del Camino (Spain) site. Quat. Internat. 275, 55–75.

Barandiarán, J.M., 1965. Exploración de la cueva de Lezetxiki (Mondragón, Campaña de 1964). Munibe 17, 38–51.

Berto, C., (Doctoral Thesis) 2013. Distribuzione ed evoluzione delle associazioni a piccoli mammiferi nella peninsola italiana durante il Pleistocene superiore. Università degli Studi di Ferrara.

Blasco, R., 2008. Human consumption of tortoises at layer IV of Bolomor Cave (Valencia, Spain). J. Archaeol. Sci. 35, 2839–2848.

Carroll, M., Kowalewski, M., Simões, M.G., Goodfriend, G.A., 2003. Quantitative estimates of time-averaging in terebratulid brachiopod shell accumulations from a modern tropical shelf. Paleobiology 29, 381–402.

Castaños, P., 1988. Estudio de los restos de la cantera de Punta Lucero (Abanto y Ciérvana, Bizkaia). Kobie 17, 157–165.

Castaños, P., Murelaga, X., Bailón, S., Castaños, J., Sáez de la Fuente, X., Suárez, O., 2009. Estudio de los vertebrados del yacimiento de Lezikako Koba (Kortezubi, Bizkaia). Kobie 28, 25–50.

Castaños, P., Murelaga, X., Arrizabalaga, A., Iriarte, M.J., 2011. First evidence of *Macaca sylvanus* (Primates, Cercopithecidae) from the Late Pleistocene of Lezetxiki II cave (Basque Country, Spain). J. Hum. Evol. 60, 816–820.

Castaños, P., Torres, T., Ortiz, J.E., Montes, R., Muñoz, E., Morlote, J.M., Santamaría, S., Castaños, J., 2012. Yacimiento paleontológico de la vertiente sur de Peña Cabarga-Pico del Castillo (Medio Cudeyo, Cantabria). Kobie 31, 5–20.

Castaños, J., Zuluaga, M.C., Ortega, L.A., Murelaga, X., Alonso-Olazabal, A., Rofes, J., Castaños, P., 2014. Carbon and nitrogen stable isotopes of bone collagen of large herbivores from the Late Pleistocene Kiputz IX cave site (Gipuzkoa, North Iberian Peninsula) for palaeoenvironmental reconstruction. Quat. Internat. 339–340, 131–138.

Cuenca-Bescós, G., Straus, L.G., González-Morales, R., García-Pimienta, J.C., 2009. The reconstruction of past environments through small mammals: from the Mousterian to the Bronze Age in El Mirón Cave (Cantabria, Spain). J. Archaeol. Sci. 36, 947–955.

Daura, J., Sanz, M., Rosell, J., Julià, R., 2010. Un cubil de carnívoros del Pleistoceno medio y superior con escasa presencia humana : la Cova del Rinoceront (Castelldefels, Barcelona). In: Baquedano, E., Rosell, J. (Eds.), Actas de la 1ª reunión de científicos sobre cubiles de hiena (y otros grandes carnívoros) en los yacimientos arqueológicos de la Península Ibérica. Zona Arqueológica 13, 494–499.

Davies, D.J., Powell, E.N., Stanton, J.R., 1989. Relative rates of shell dissolution and net sediment accumulation – a commentary: can Shell beds form by the gradual accumulation of biogenic debris on the sea floor? Lethaia 22, 207–212.

Domingo, R., Peña-Monné, J.L., de Torres, T., Ortiz, J.E., Utrilla, P., 2015. Neanderthal highlanders: Las Callejuelas (Monteagudo del Castillo, Teruel, Spain), a high-altitude site occupied during MIS 5. Quat. Internat., http://dx.doi.org/10.1016/j.quaint.2015.09.088 (in press).

EVE, 1995. Mapa Geológico del País Vasco 1:100,000. Ente Vasco de Energía.

Fernández Rodríguez, C., 1989. Identificación y análisis de la fauna del yacimiento paleolítico de la Cueva de A Valiña. Tesina de Licenciatura. Departamento de Historia I. Universidad de Santiago.

Garcia-Ibaibarriaga, N., Arrizabalaga, A., Iriarte-Chiapusso, M.J., Rofes, J., Murelaga, X., 2015. The return to the Iberian Peninsula: first Quaternary record of *Muscardinus* and a palaeogeographical overview of the genus in Europe. Quat. Sci. Rev. 119, 106–115.

Grandal D'Anglade, A., (Doctoral Thesis) 1993. El oso de las cavernas en Galicia : El yacimiento de Cova Eiros. Laboratorio Xeoloxico de Laxe.

Haugen, J.E., Sejrup, H.P., 1992. Isoleucine epimerization kinetics in the shells of *Arctica islandica*. Nor. Geol. Tidsskr 72, 171–180.

Helmens, K.F., 2014. The Last Interglacial-Glacial cycle (MIS 5-2) re-examined based on long proxy records from central and northern Europe. Quat. Sci. Rev. 86, 115–143.

Kidwell, S.M., 1998. Time-averaging in the marine fossils record: overview of strategies and uncertainties. Geobios 30, 977–995.

Kidwell, S.M., Best, M.M., Kaufman, D.S., 2005. Taphonomic trade-offs in tropical marine death assemblages: differential time-averaging, shell loss, and probable bias in siliciclastic vs. carbonate facies. Geology 33, 729–732.

López, E., 2003. Paleontology and taphonomy of Pleistocene mammals of Galicia (NW Iberian Peninsula). Serie "Nova Terra", 22. Laboratorio Xeolóxico de Laxe, pp. 1–323.

Martínez Valle, R., 2009. 3. Restos óseos de macromamíferos y aves. In: Villaverde, V., Pérez Ballester, J., Ledo, A.C. (Eds.), Historia de Xàtiva. Vol. I. Prehistoria, Arqueología y Antigüedad. II. Los primeros pobladores de la Costera : los neandertales de la Cova Negra de Xàtiva. Excm. Ajuntament de Xàtiva.

Maul, L., 1990. Überblick über die unterpleistozänen Kleinsäugerfaunen Europas. Quartärpaläont. 8, 153–191.

Meldahl, K.H., Flessa, K.W., Cutler, A.H., 1997. Time-averaging and postmortem skeletal survival in benthic fossil assemblages: quantitative comparisons among Holocene environments. Paleobiol. 23, 207–229.

Murray-Wallace, C.V., 1995. Aminostratigraphy of Quaternary coastal sequences in southern Australia, an overview. Quat. Internat. 26, 69–86.

Ortiz, J.E., Torres, T., Pérez-Gonzalez, A., 2013. Amino acid racemization in four species of ostracodes: taxonomic, environmental, and microstructural controls. Quat. Geochronol. 16, 129–143.

Ortiz, J.E., Gutiérrez-Zugasti, I., Torres, T., González-Morales, M., Sánchez-Palencia, Y., 2015a. Protein diagenesis in *Patella* shells: implications for amino acid racemization dating. Quat. Geochronol. 27, 105–118.

Ortiz, J.E., Torres, T., Ramallo, S.F., Ros, M., 2015b. Algoritmos de datación por racemización de aminoácidos de ostrácodos del Holoceno y Pleistoceno superior en la Península Ibérica. Geogaceta 58, 59–62.

Panera, J., Pérez-González, A., Rubio Jara, S., Sesé, C., 2005. El yacimiento paleolítico de HAT en el valle del Jarama : una aportación de Cuaternario de la cuenca de Madrid al debate sobre el inicio del Paleolítico medio. In: Santonja, M., Pérez-González, A., Machado, M.J. (Eds.), Geoarqueología y Patrimonio en la Península Ibérica y el entorno Mediterráneo. ADEMA, Soria, pp. 251–260.

Pemán, E., 1985. Aspectos climáticos y ecológicos de los micromamíferos del yacimiento de Erralla. Munibe 37, 49–57.

Penkman, K.E.H., Kaufman, D.S., Maddy, D., Collins, M.J., 2008. Closed-system behaviour of the intra-crystalline fraction of amino acids in mollusk shells. Quat. Geochronol. 3, 2–25.

Pokines, J.T., 1998. The Paleoecology of Lower Magdalenian Cantabrian Spain. Bar Int. Ser. 713, 1–189.

Rofes, J., (Doctoral Thesis) 2009. Los sorícidos (Mammalia,Eulipotyphla) del Pleistoceno Inferior de los yacimientos de la Sierra de Atapuerca, Burgos, España. Universidad de Zaragoza, pp. 295.

Rofes, J., Garcia-Ibaibarriaga, N., Murelaga, X., Arrizabalaga, A., Iriarte, M.J., Cuenca-Bescós, G., Villaluenga, A., 2012. The southwesternmost record of *Sicista* (Mammalia; Dipodidae) in Eurasia, with a review of the palaeogeography and palaeoecology of the genus in Europe. Palaeogeogr. Palaeoclimatol. Palaeoecol. 348–349, 67–73.

Rofes, J., Zuluaga, M.C., Murelaga, X., Férnandez-Eraso, J., Bailon, S., Iriarte, M.J., Ortega, L.A., Alonso-Olazabal, A., 2013. Paleoenvironmental reconstruction of the Early Neolithic to Middle Bronze Age Peña Larga rock shelter (Álava, Spain) from the small mammal record. Quat. Res. 79, 158–167.

Rofes, J., Murelaga, X., Martínez-García, B., Bailon, S., López-Quintana, J.C., Guenaga-Lizasu, A., Ortega, L.A., Zuluaga, M.C., Alonso-Olazabal, A., Castaños, J., Castaños, P., 2014. The long paleoenvironmental sequence of Santimamiñe (Bizkaia, Spain): 20,000 years of small mammal record from the latest Late Pleistocene to the Middle Holocene. Quat. Internat. 339–340, 62–75.

Rofes, J., Garcia-Ibaibarriaga, N., Aguirre, M., Martínez-García, B., Ortega, L., Zuluaga, M.C., Bailon, S., Alonso-Olazabal, A., Castaños, J., Murelaga, X., 2015. Combining small-vertebrate, marine and stable-isotope data to reconstruct past environments. Sci. Rep. 5, 14219.

Rosell, J., Blasco, R., Rivals, F., Chacón, M.G., Menéndez, L., Morales, J.I., Rodríguez-Hidalgo, A., Cebria, A., Carbonell, E., Serrat, D., 2010. A stop along the way: the role of Neanderthal groups at layer III of Teixoneres Cave (Moià, Barcelona, Spain). Quat. Internat. 21, 139–154.

Sesé, C., 2005. Aportación de los micromamíferos al conocimiento paleoambiental del Pleistoceno. Nuevos datos y síntesis Superior en la Región Cantábrica. Monogr. Cent. Invest Mus Altamira 20, 167–200.

Torres, T., Cobo, R., Salazar, A., 1993. Primeros resultados de la excavación paleontológica de la Cueva de Troskaeta'ko Kobea en Ataun, Guipúzcoa (España). El Cuaternario en España y Portugal, vol. 1., pp. 291–299.

Torres, T., Ortiz, J.E., Fernández, E., Arroyo-Pardo, E., Grün, R., Pérez-González, A., 2014. Aspartic acid racemization as a dating tool for dentine: a reality. Quat. Geochronol. 22, 43–56.

Wehmiller, J.F., 1980. Intergeneric differences in apparent racemization kinetics in mollusks and foraminifera: implications for models of diagenetic racemization. In: Hare, P.E. (Ed.), Offprints from Biogeochemistry of Amino Acids. John Wiley and Sons, New York, pp. 341–355.